CERES FLASHFlux Status:

Near-Real Time Surface Radiative Fluxes and Meteorology for Research and Applications

Paul Stackhouse, David P. Kratz, and Takmeng Wong, (NASA LaRC)

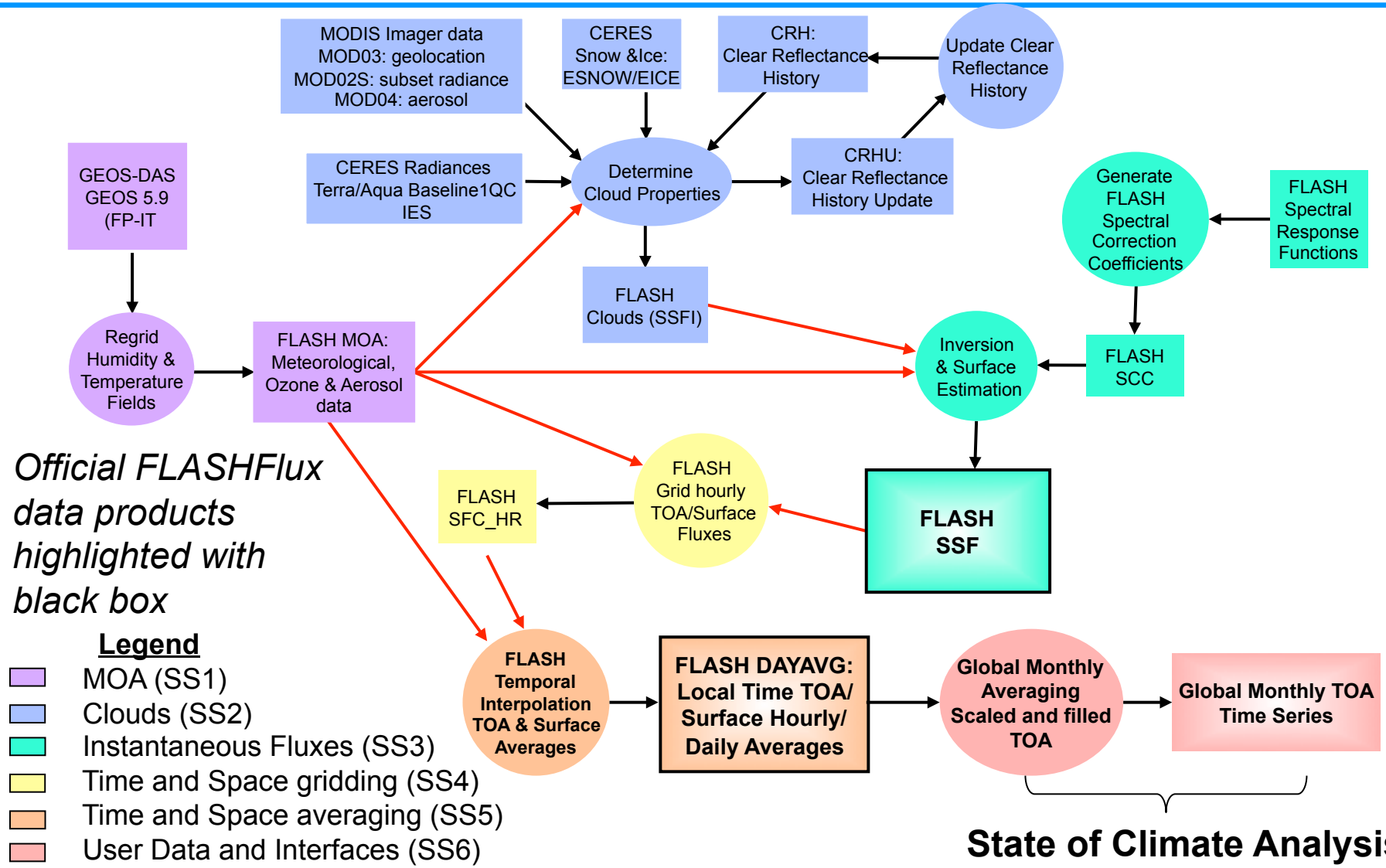
PC Sawaengphokhai, Shashi Gupta and Anne Wilber (SSAI)

Tonya Davenport, Lindsay Parker and the Atmospheric Science Data Center Team (SSAI)

CERES FLASHFlux Overview

- ***FLASHFLUX = Fast Longwave And SHortwave Radiative Fluxes from CERES and MODIS***
- ***FLASHFlux Objectives:***
  - Provide TOA and surface radiative fluxes within one week of observation for scientific and applied science uses:
    - Level 2 – SSF for Terra and Aqua; currently through 4/19/14
    - Level 3 – TISA, Terra+Aqua,1°x1°; currently through 4/16/14
  - Scientific, Educational and Applied Science use examples:
    - CloudSat and Megha-Tropiques (SSF)
    - Annual "State of the Climate" report on radiative budgets (TISA)
    - CERES S'COOL, NASA Earth Observatory (TISA)
    - LaRC POWER (TISA): Building energy monitoring through (RETSCreen); Crop modeling systems such as APSIM (CSIRO)
  - Demonstrate processing system pushing data products to research and applications uses
    - Push subscription from ASDC to NASA Earth Observatory for Education
    - Pull from ASDC by CloudSat and Megha-Tropiques missions
    - Direct usage via DPO at NASA LaRC: CERES team, POWER

FLASHFlux Data Flow (v3A)



FLASHFlux SSF Data Products

FLASHFlux SSF Version 3A Products

Processed through about 4/19/2014)

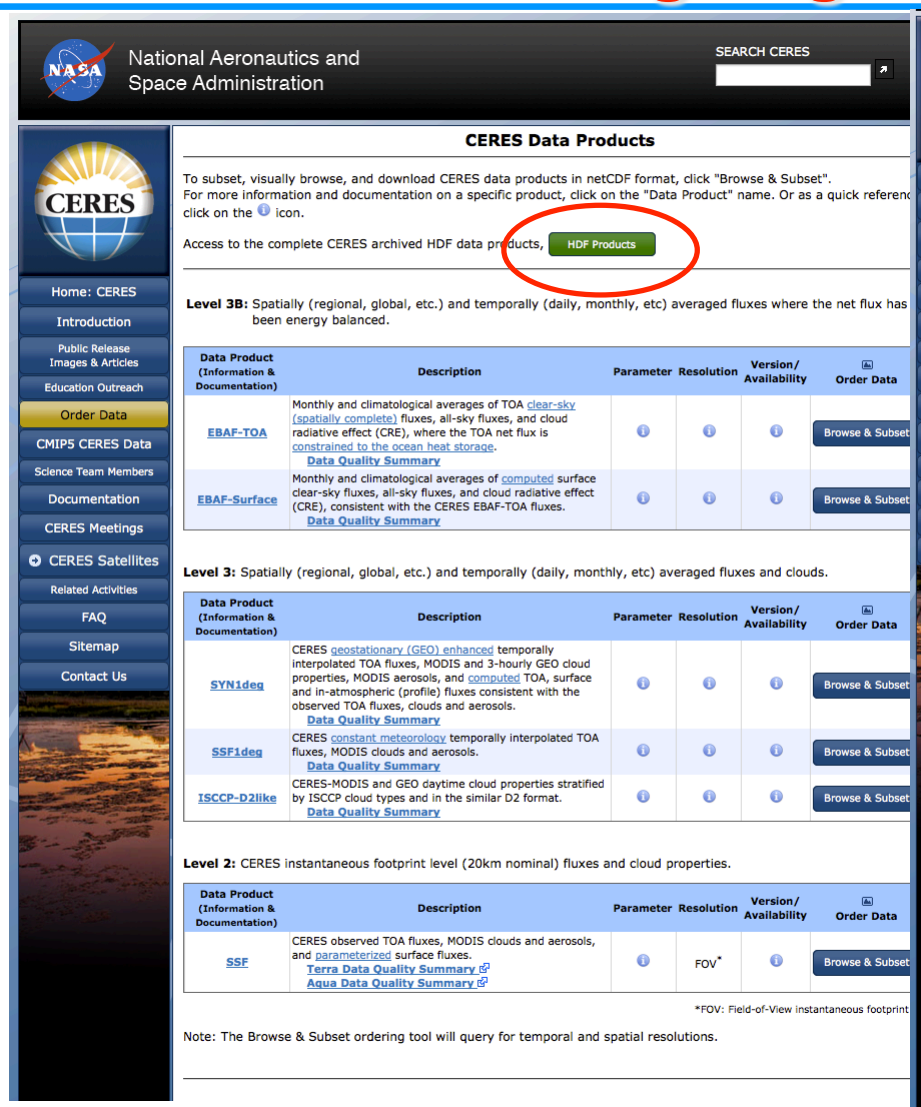
https://eosweb.larc.nasa.gov/project/ceres/flashflux-l2_table

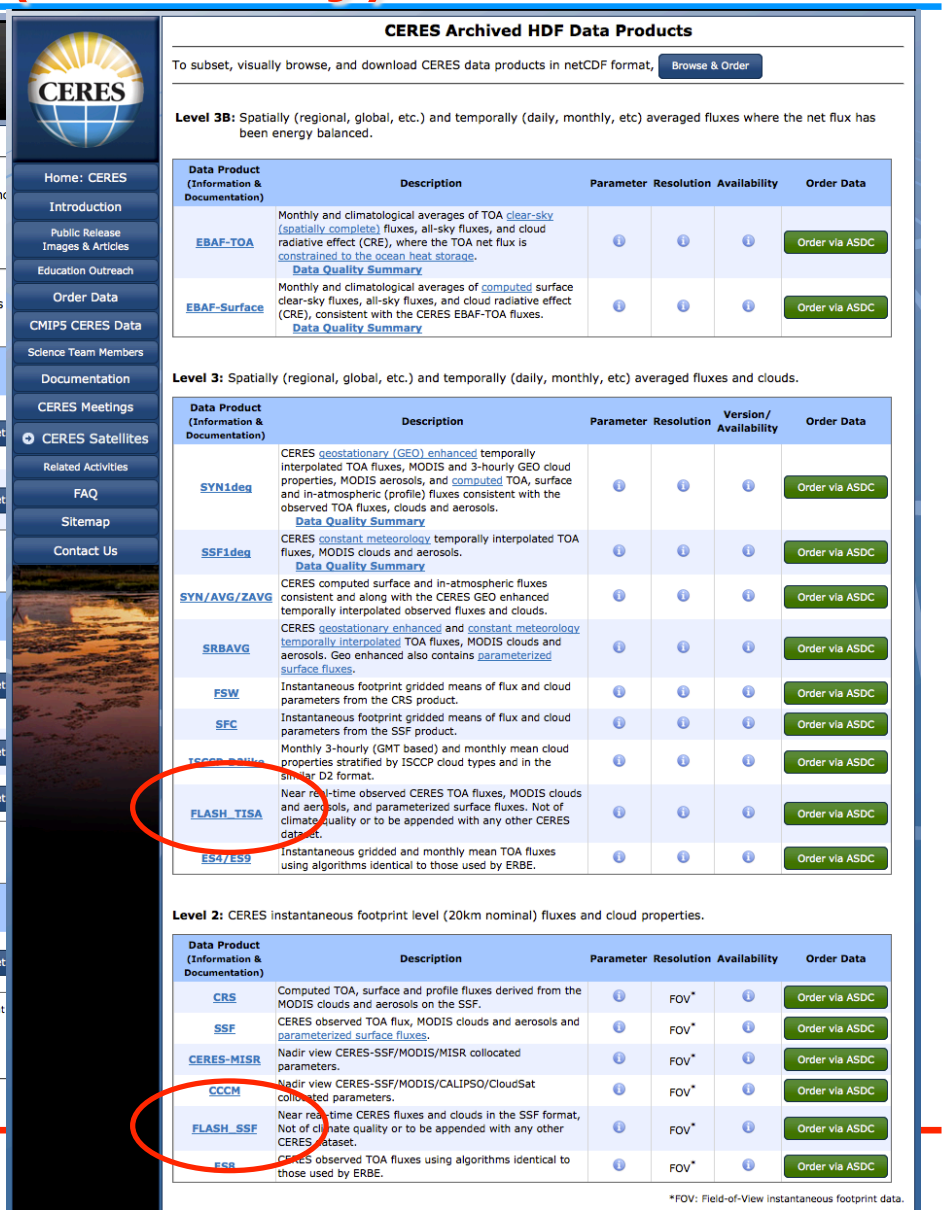
FLASHFlux TISA Data Products

FLASHFlux TISA Version 3A Products (Terra+Aqua; Daily; 1ºx1º resolution; Processed through about 4/9/2014)

https://eosweb.larc.nasa.gov/project/ceres/flashflux-tisa_table

Finding FLASHFlux from CERES Data Ordering Page (HDF Only)





SSF Paper Published

The Fast Longwave and Shortwave Flux (FLASHFlux) Data Product: Single-Scanner Footprint Fluxes

DAVID P. KRATZ AND PAUL W. STACKHOUSE JR.
Science Directorate, NASA Langley Research Center, Hampton, Virginia

SHASHI K. GUPTA, ANNE C. WILBER, AND PARNCHAI SAWAENGPHOKHAI
Science Systems and Applications Inc., Hampton, Virginia

GREG R. MCGARRAGH
Colorado State University, Fort Collins, Colorado

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ABSTRACT

The Clouds and the Earth's Radiant Energy Systems (CERES) project utilizes radiometric measurements taken aboard the *Terra* and *Aqua* spacecrafts to derive the world-class data products needed for climate research. Achieving the exceptional fidelity of the CERES data products, however, requires a considerable amount of processing to assure quality and to verify accuracy and precision, which results in the CERES data being released more than 6 months after the satellite observations. For most climate studies such delays are of little consequence; however, there are a significant number of near–real time uses for CERES data products. The Fast Longwave and Shortwave Radiative Flux (FLASHFlux) data product was therefore developed to provide a rapid release version of the CERES results, which could be made available to the research and applications communities within 1 week of the satellite observations by exchanging some accuracy for speed. FLASHFlux has both achieved this 1-week processing objective and demonstrated the ability to provide remarkably good agreement when compared with the CERES data products for both the instantaneous single-scanner footprint (SSF) fluxes and the time- and space-averaged (TISA) fluxes. This paper describes the methods used to expedite the production of the FLASHFlux SSF fluxes by utilizing data from the CERES and Moderate Resolution Imaging Spectroradiometer instruments, as well as other meteorological sources. This paper also reports on the validation of the FLASHFlux SSF results against ground-truth measurements and the intercomparison of FLASHFlux and CERES SSF results. A complementary paper will discuss the production and validation of the FLASHFlux TISA fluxes.

1. Introduction

Defining the radiative energy exchange at the top of the earth–atmosphere system and at the earth's surface has long been identified as critical to understanding climate processes (Suttles and Ohring 1986; GCOS 2003) and remains an active focus of research (Stephens et al. 2012; Wild et al. 2013). The reflected shortwave (SW) and outgoing longwave (LW) fluxes at the top of the atmosphere (TOA) constitute the radiative energy exchange of the entire earth–atmosphere system driven by the magnitude of the incoming total solar irradiance, while the surface energy budget constitutes the energy exchange between the atmosphere and the earth's surface driven by radiative, sensible, and latent heating processes. Accurate derivations of the TOA and surface radiative quantities allow for closure in the atmospheric radiative budget and improvement in the calculations of the inferred heat transports within the earth–atmosphere system. The LW and SW net surface fluxes affect the heating–cooling of the surface and thus provide bounds for sensible and latent heat fluxes, as well as estimates for the horizontal oceanic and atmospheric heat transport. Changes to the input energy into the surface systems affect short- and long-term weather- and climate-related processes (Fasullo and Trenberth 2008a,b). Changes to

Corresponding author address: Dr. David P. Kratz, NASA Langley Research Center, Mail Stop 420, Hampton, VA 23681-2199.
E-mail: david.p.kratz@nasa.gov

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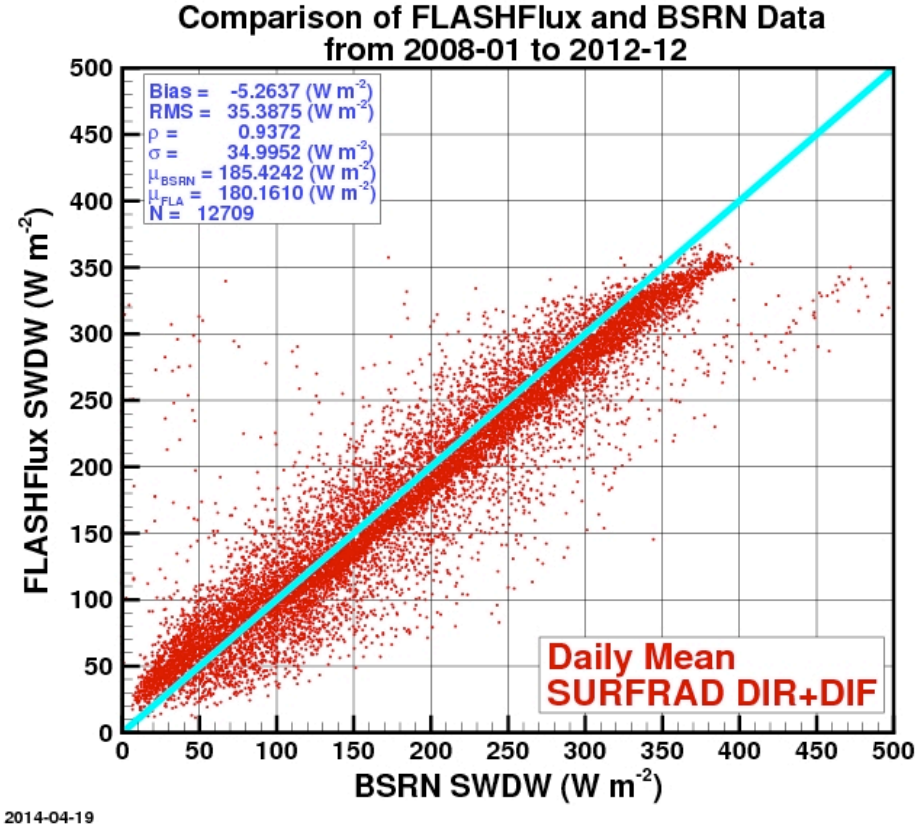
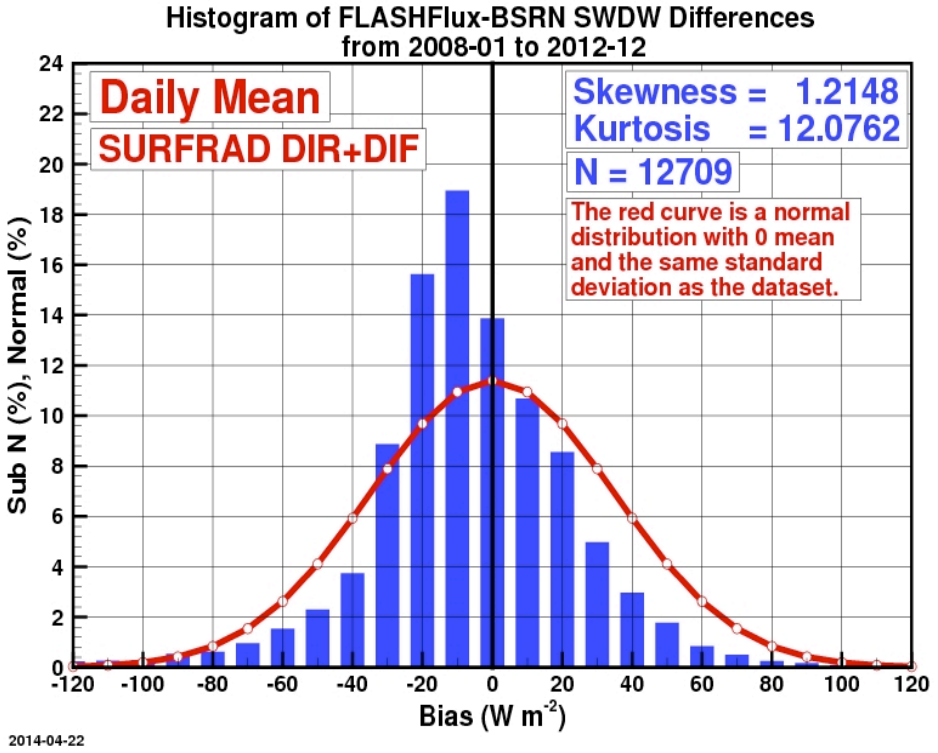
- ***Published in the Journal of Applied Meteorology and Climatology in April issue.***
- ***Highlights the production and validation of the FLASHFlux SSF data product.***
- ***Compares well with CERES SSF data product.***
- ***TISA paper in progress.***

FLASHFlux TISA Validation

SW SURFRAD Measurements Only (2008-2012)

Version 2H

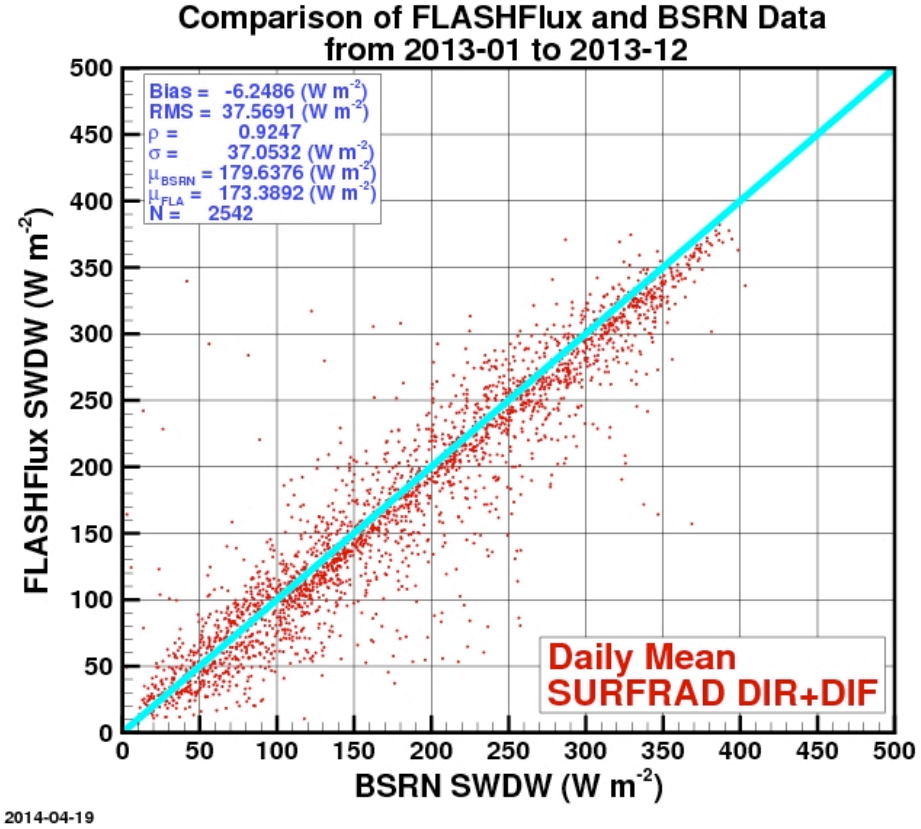


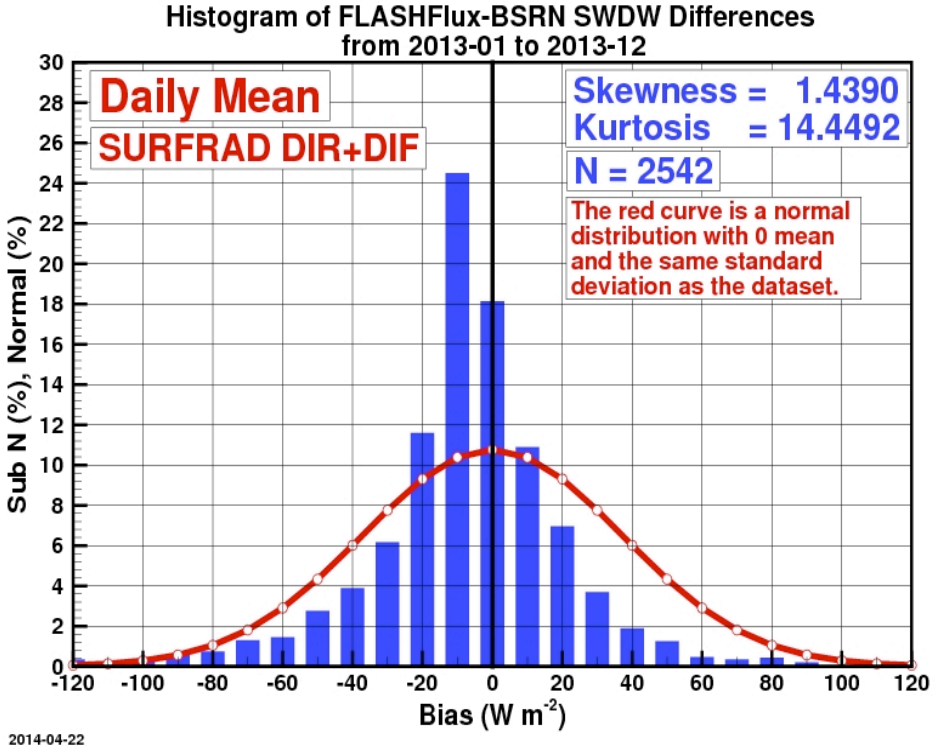


FLASHFlux TISA Validation

SW SURFRAD Measurements Only (2013)

Version 3A





FLASHFlux TISA Validation

LW SURFRAD Measurements Only (2008-2012)

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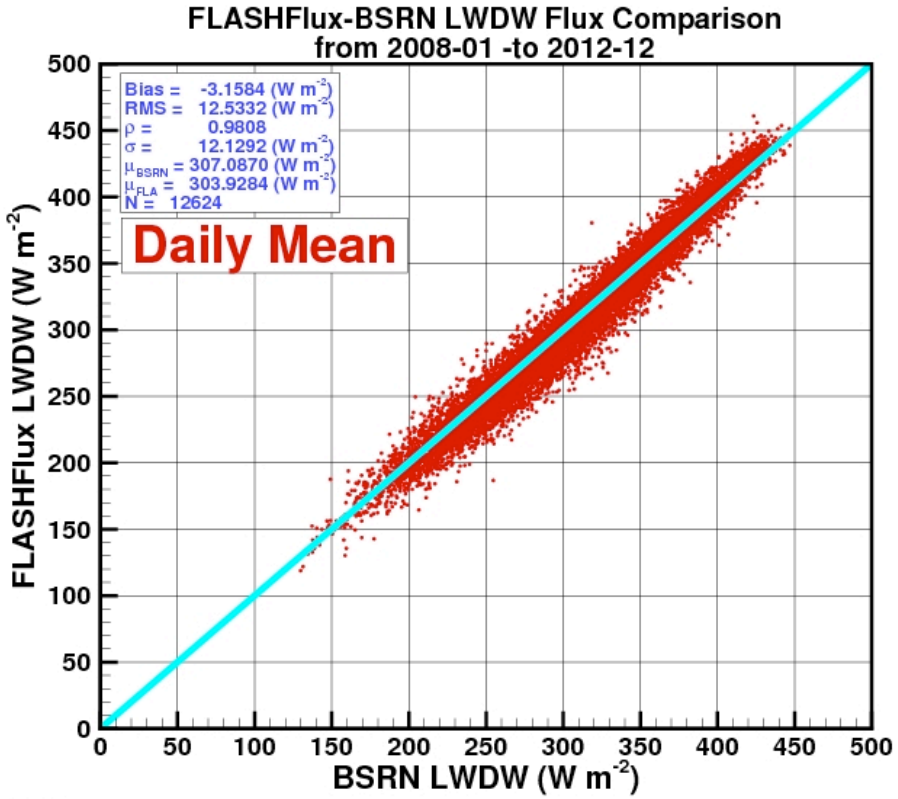
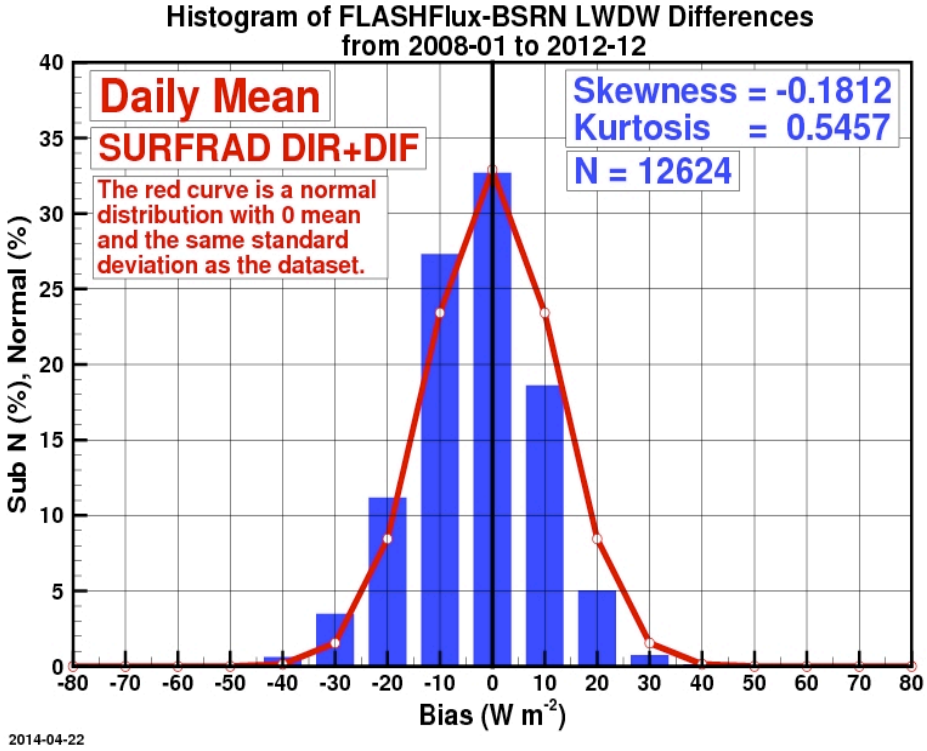
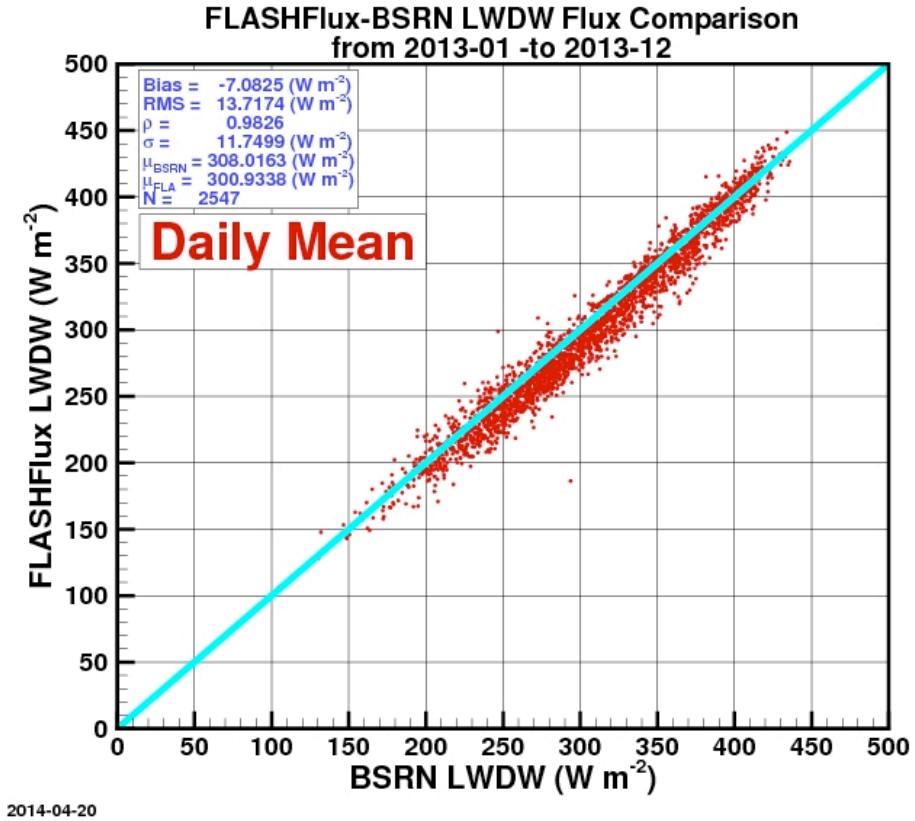


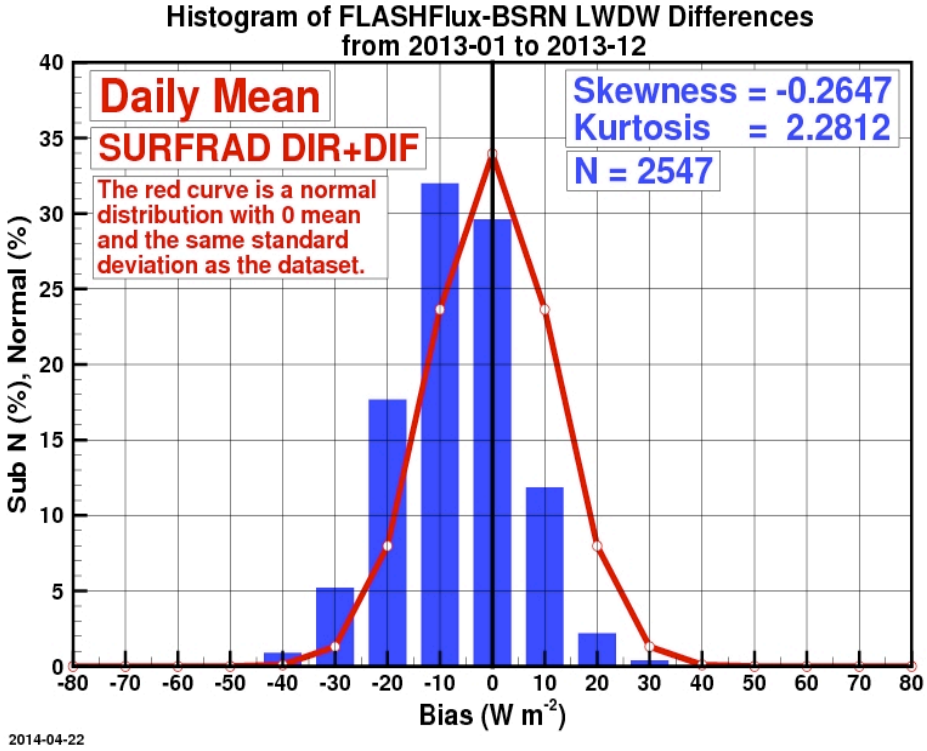


FLASHFlux TISA Validation

LW SURFRAD Measurements Only (2013)

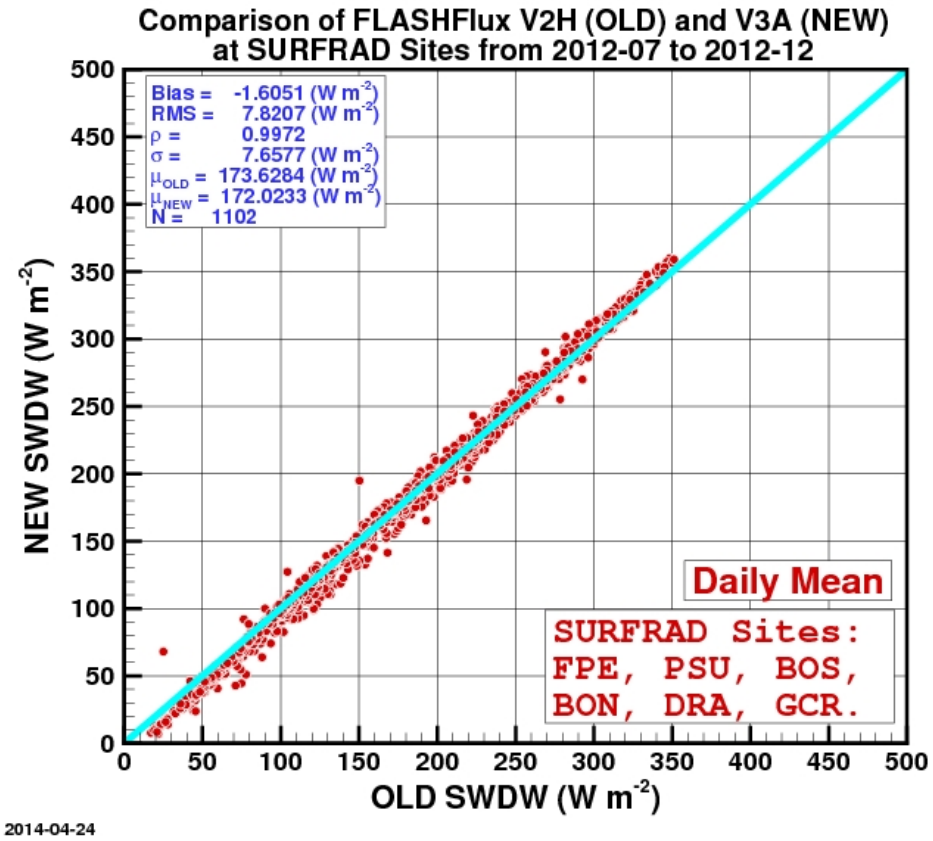
Version 3A



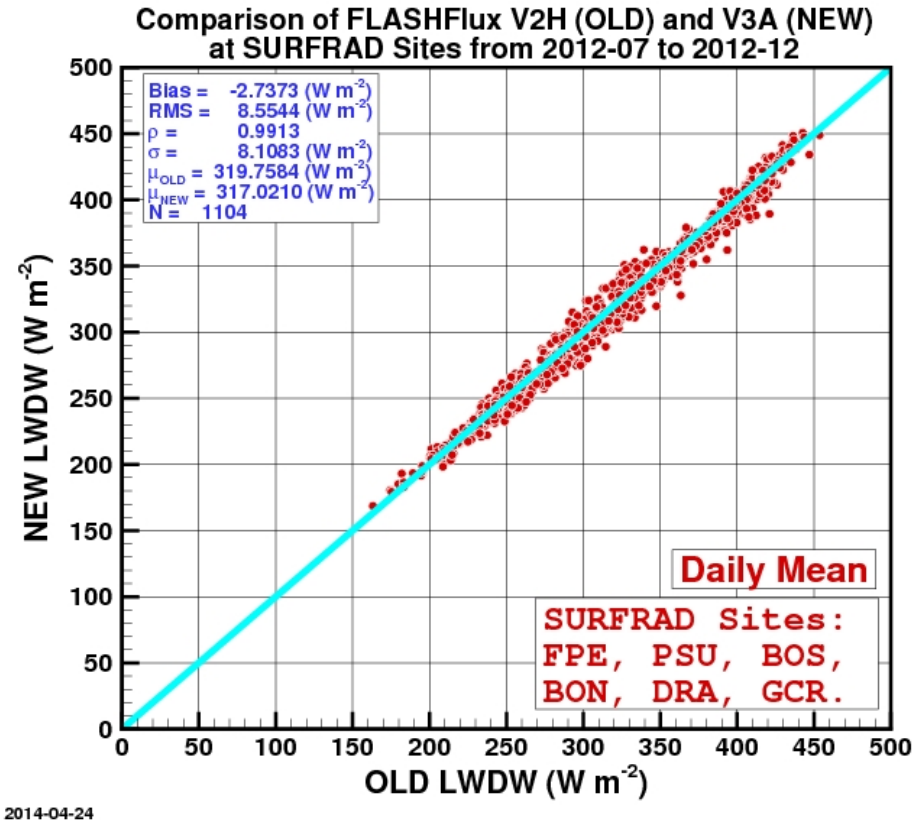


FLASHFlux TISA v2H v v3a

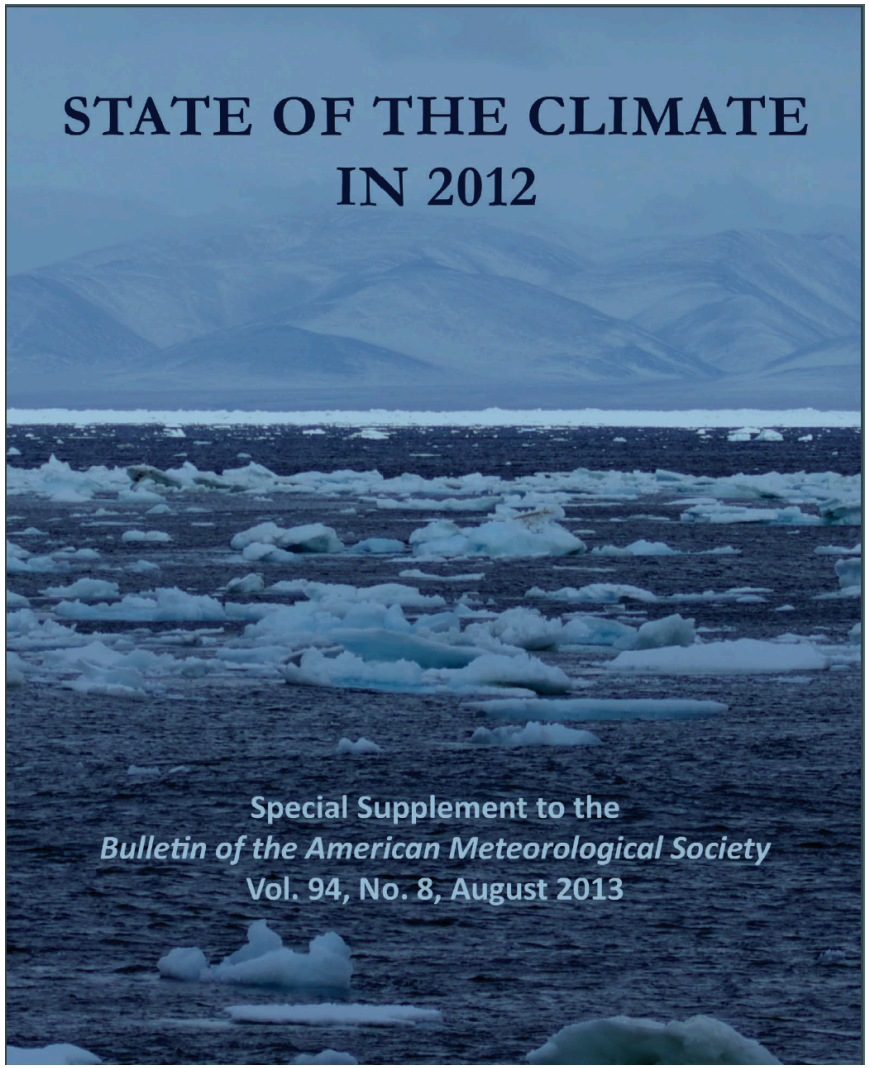
SW Surface Downward Flux



LW Surface Downward Flux



State of the Climate 2012 Published



- ***CERES FLASHFlux contributed to the special annual BAMS report on the "State of the Climate in 2012".***
- ***Issue appeared in Aug. 2013, providing estimates of changes in year to year Global Earth Radiation Budget for the first time.***
- ***These data were extended and normalized relative to the CERES EBAF 2.6r products for this report.***

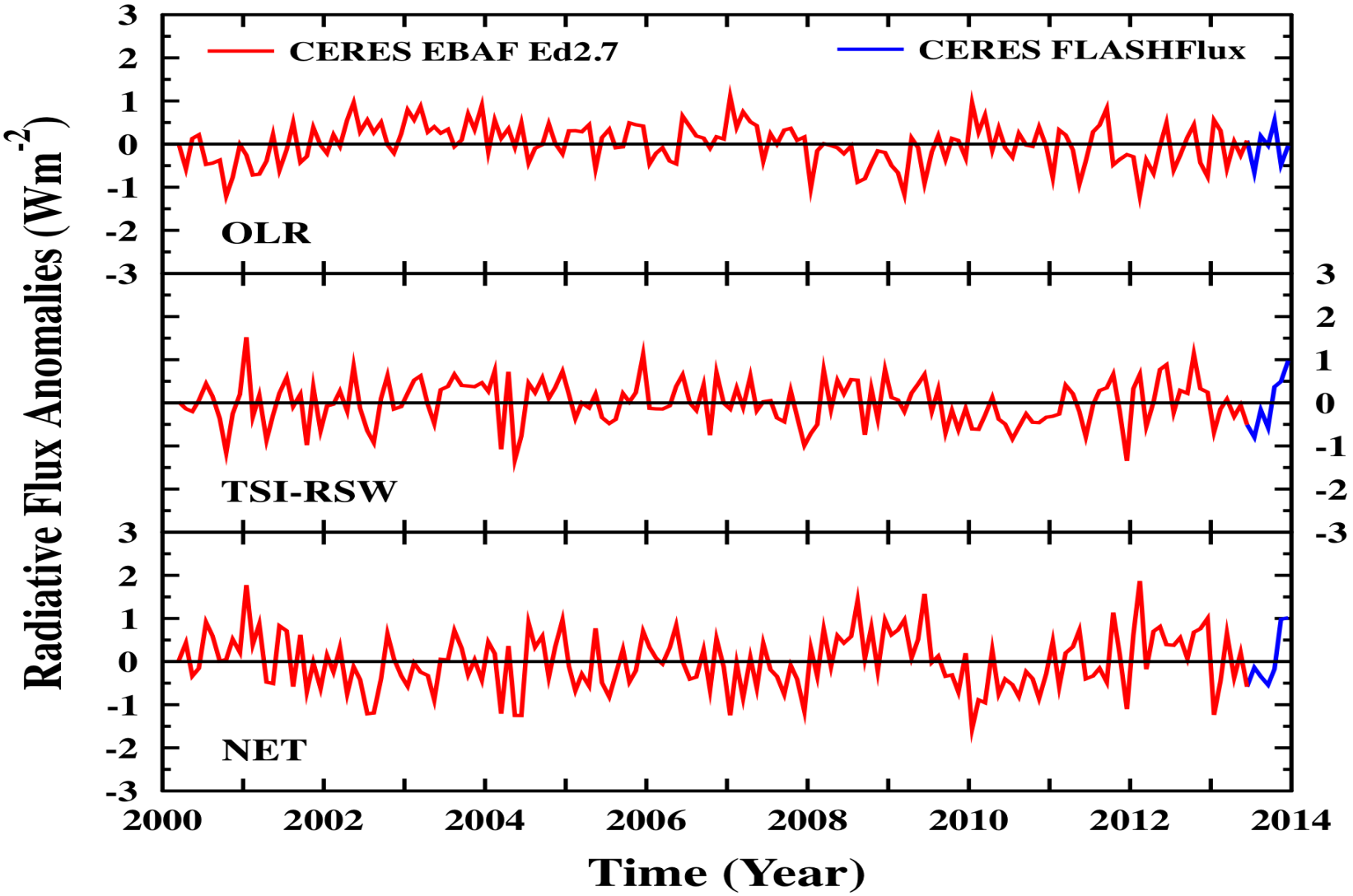
State of the Climate 2013 Analysis

CERES FLASHFlux TOA flux variability for 2013 for BAMS "State of the Climate" report:

- TSI for SORCE had to be normalized relative to RMIB
- Overlap with EBAF from July 2012 to June 2013 used to adjust FLASHFlux TOA 3A fluxes
- 2σ monthly uncertainty (W m^{-2}) = ±0.34, ±0.05, ±0.84 and ±0.93 Wm^{-2} for the OLR, TSI, RSW and NET radiation
- Global annual average anomalies and variability (in 2σ):

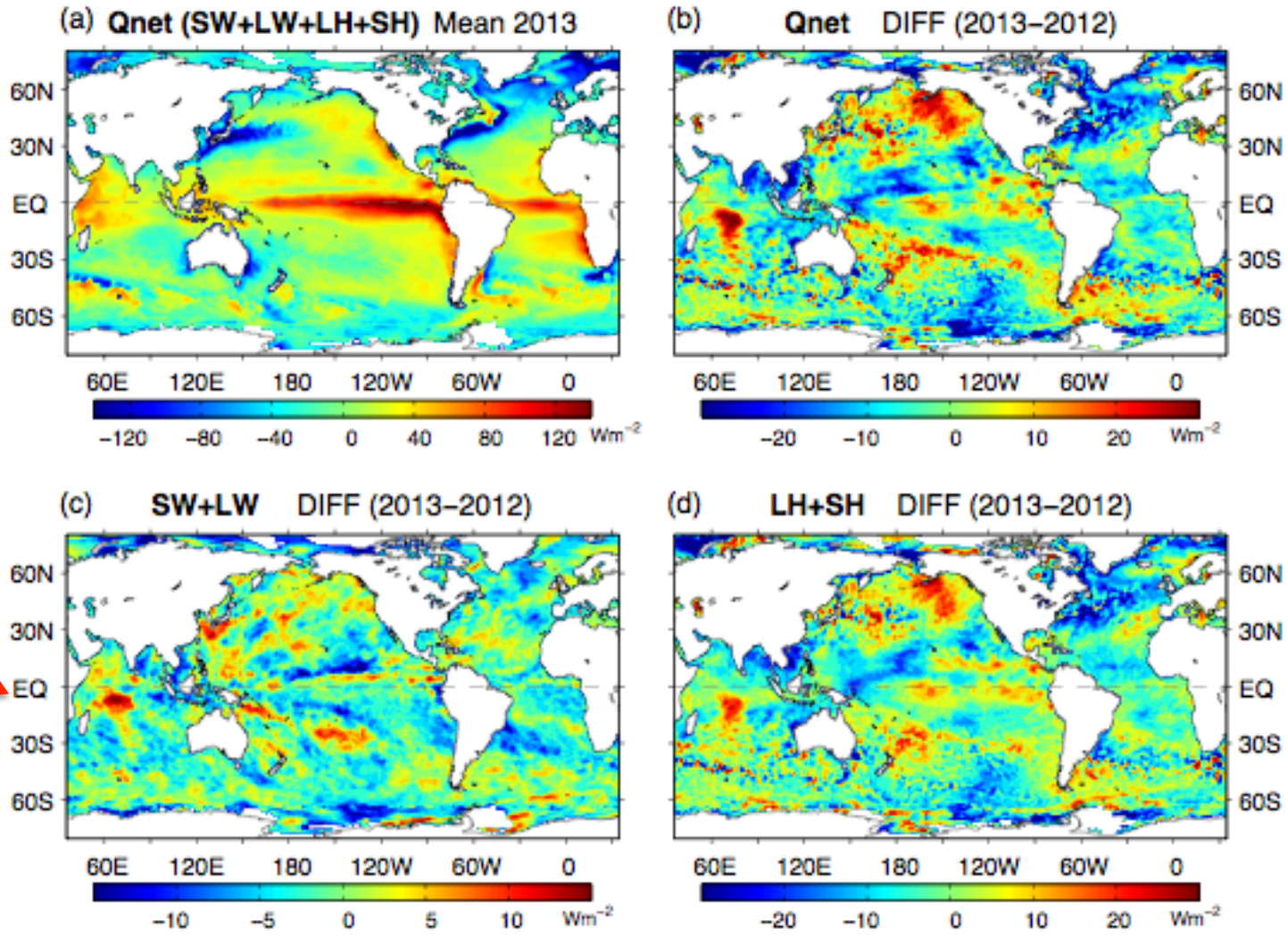
	One year change (2013 minus 2012) (Wm^{-2})	2013 anomaly (relative to climatology) (Wm^{-2})	Interannual variability (2001 to 2012) (Wm^{-2})
OLR	+0.25	–0.05	±0.50
TSI	+0.00	+0.05	±0.20
RSW	+0.45	+0.20	±0.40
Net	–0.70	–0.10	±0.70

State of the Climate 2013 Analysis



Net Surface Flux Differences (2013-2012)

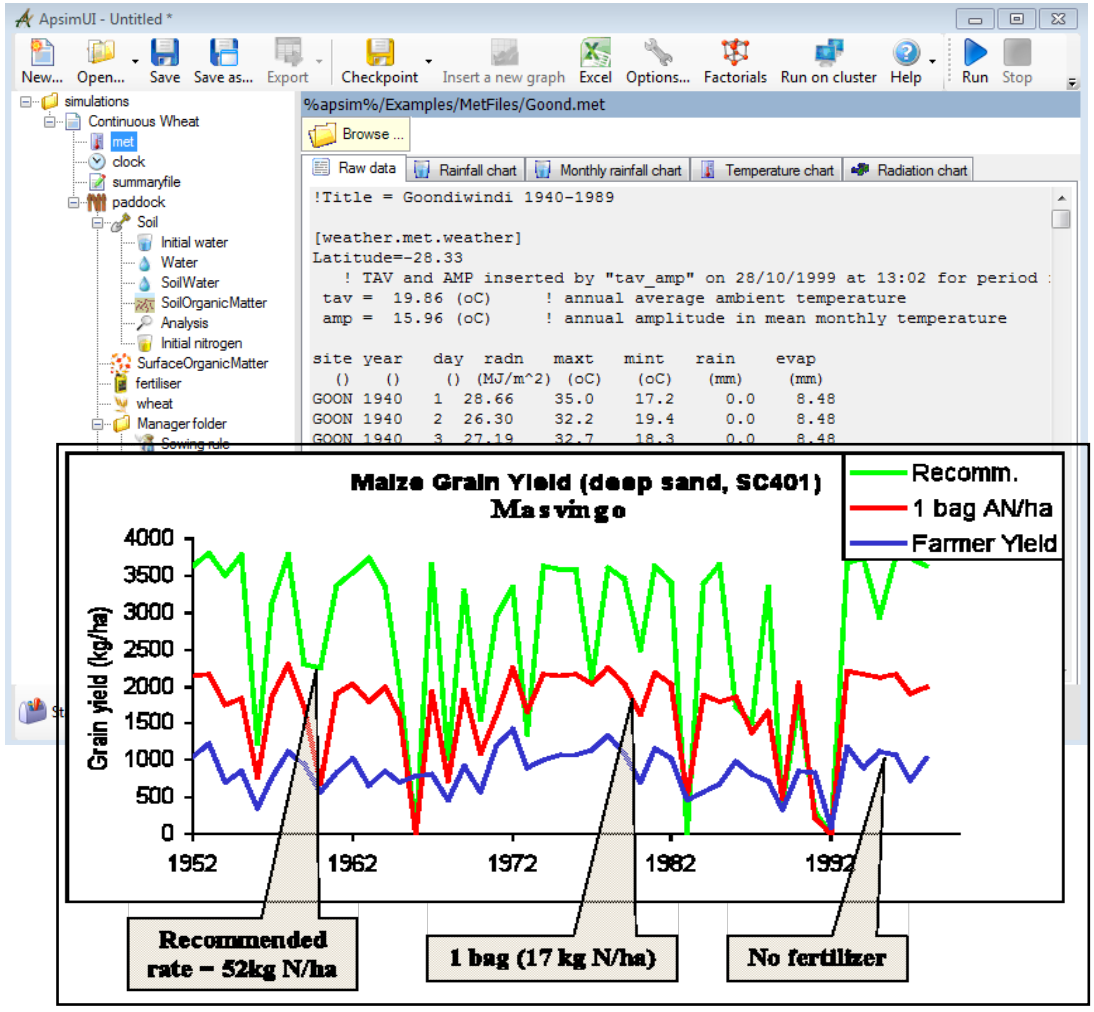
Lisan Yu (WHOI), OAFlux With FLASH-Flux net surface flux changes 2013-2012



CERES FLASHFlux Agricultural Usage: CSIRO APSIM African Crop Modeling Project

APSIM (The Agricultural Production Systems sIMulator)

- internationally recognized as a highly advanced simulator of agricultural systems.
- DSSAT based formatted model
- Run for crop systems in West, East and Southern Africa
- FLASHFlux surface fluxes are “gold standard” of surface irradiance estimates for these regions (surface measurements are too poorly calibrated and/or maintained)
- Also uses surface temperature and other parameters from GEOS FP-IT



Results complements of John Hargreaves, CSIRO

CERES FLASHFlux Energy Usage: RETScreen Performance Plus

RETScreen Performance Plus (imbedded in RETScreen Suite)

- Internationally recognized for monitoring, targeting and verification of clean energy technologies in operational building systems
- Special ASCII time series format used for SW + meteorological parameters from GEOS FP-IT
- RETScreen reports at least 20,000 users worldwide with most using the NASA data sets from FLASHFlux production
- Example usage includes Weston Bakeries (Wonder Bread), Ford Motor Company, Property management firms, government buildings (i.e., NASA), etc.

Future Upgrades and Challenges

- ***Update to v3B***
  - Correct production code anomaly in SSF surface fluxes
  - Update calibration (working with CERES Instrument team)
  - Daily FF TISA TOA and surface fluxes to netCDF format to support inclusion in CERES subsetter (increase visibility)
- ***Continued refinement of algorithms:***
  - Improve near-real time surface albedo to reflect surface condition (support for ARISE – Arctic radiation experiment)
  - Aerosols: evaluation FP-IT compared to “Fast-MATCH”
- ***Future Upgrades***
  - CERES Ed 4 Clouds (MODIS Collection 6) and Inversion
  - Improve consistency between CERES algorithms and FLASHFlux (TISA/SYN)
  - Develop FLASHFlux NPP SSF data product stream
- ***Continued/improved support for applications (Solar industry, Agriculture, Building assessment)***

Summary and Conclusions

- ***FLASHFlux 3A***
  - Continuing production and validation
  - New version featuring netCDF delivered soon
  - Improving/upgrading algorithms will work with TISA team to increase similarity to current CERES products
  - Will coordinate with Clouds and Inversion teams to adapt to Ed 4
  - Plan to begin work on NPP SSF production system as new modules arrive
- ***FLASHFlux Applications:***
  - Expanding usage for Energy applications using RETScreen and other clean energy applications
  - Also noting expanded usage in building infrastructure risks applications
- ***FLASHFlux publications:***
  - SSF published; TISA paper next (renewable energy journal?)
  - 2013 SotC reports submitted

FLASHFlux Web Sites:

http://flashflux.larc.nasa.gov

Backup Slides

NASA LaRC CASI Analysis

- ***NASA CASI:***
  - NASA has instituted a Climate Adaptation Science Investigation (CASI) team to assess NASA building infrastructure risks to potential changes in climate
  - Part of the assessment is a review of energy performance of buildings under varying meteorological conditions
  - LaRC's team is assessing 4 buildings for team and with the intent to provide tutorial for other centers
  - Analysis uses RETScreen Performance Plus tool
  - Data sets from CERES FLASHFlux production allow computation of parameters to near-real time

CERES vs FLASHFlux TOA Fluxes

TABLE 1. Difference between the FLASHFlux and CERES LW TOA fluxes (FLASHFlux − CERES) for clear-sky and cloudy-sky conditions based on the *Terra* and *Aqua* measurements at the overpass times. The seven scene types are representative of the earth's surface and consist of subgroups derived from the 20 IGBP surface types. The first column represents the scene type. The second and fourth columns represent the systematic differences (bias) and the third and fifth columns represent the RMSs between the FLASHFlux and CERES model-derived fluxes for the clear- and cloud-sky cases, respectively.

Terra	Clear sky		Cloudy sky	
Type	Bias ($W m^{-2}$) (%)	RMS ($W m^{-2}$) (%)	Bias ($W m^{-2}$) (%)	RMS ($W m^{-2}$) (%)
Forest	−0.7 (−0.3)	1.1 (0.4)	−2.2 (−1.0)	6.2 (2.7)
Grassland	−1.2 (−0.4)	3.2 (1.1)	−2.3 (−1.0)	10.4 (4.4)
Cropland–urban	−0.9 (−0.3)	1.4 (0.5)	−2.4 (−1.0)	6.6 (2.9)
Bright desert	−3.1 (−1.0)	4.2 (1.4)	−2.1 (−0.8)	11.0 (4.2)
Tundra–barren	−1.6 (−0.5)	3.1 (1.0)	−1.9 (−0.8)	9.5 (3.9)
Water	−1.0 (−0.3)	1.4 (0.5)	−2.1 (−0.8)	5.4 (2.2)
Snow–ice	−2.4 (−1.3)	3.8 (2.1)	−1.7 (−0.9)	6.9 (3.8)
Aqua	Clear sky		Cloudy sky	
Type	Bias ($W m^{-2}$) (%)	RMS ($W m^{-2}$) (%)	Bias ($W m^{-2}$) (%)	RMS ($W m^{-2}$) (%)
Forest	−0.9 (−0.3)	1.3 (0.5)	−2.5 (−1.1)	6.8 (3.0)
Grassland	−1.5 (−0.5)	3.3 (1.1)	−2.7 (−1.1)	7.7 (3.2)
Cropland–urban	−1.1 (−0.4)	1.6 (0.6)	−2.7 (−1.2)	6.9 (3.0)
Bright desert	−3.4 (−1.1)	4.3 (1.4)	−2.7 (−1.0)	7.5 (2.8)
Tundra–barren	−1.8 (−0.6)	2.9 (1.0)	−2.7 (−1.1)	9.3 (3.7)
Water	−0.6 (−0.2)	1.0 (0.3)	−1.6 (−0.6)	4.6 (1.9)
Snow–ice	−1.4 (−0.8)	3.0 (1.8)	−1.7 (−1.0)	9.2 (5.1)

CERES vs FLASHFlux SSF TOA Fluxes

TABLE 2. As in Table 1, but for the SW.

Terra Type	Clear sky Bias ($W m^{-2}$) (%)	Clear sky RMS ($W m^{-2}$) (%)	Cloudy sky Bias ($W m^{-2}$) (%)	Cloudy sky RMS ($W m^{-2}$) (%)
Forest	−0.1 (−0.1)	1.7 (1.3)	0.7 (0.2)	6.3 (2.0)
Grassland	0.2 (0.1)	1.8 (1.0)	0.7 (0.2)	5.4 (1.7)
Cropland–urban	0.1 (0.1)	2.0 (1.3)	0.7 (0.2)	9.4 (3.0)
Bright desert	1.1 (0.4)	3.1 (1.0)	0.9 (0.3)	6.6 (2.1)
Tundra–barren	0.5 (0.3)	3.1 (1.4)	0.9 (0.3)	14.0 (5.3)
Water	−0.5 (−0.6)	2.3 (2.6)	0.0 (0.0)	5.8 (2.5)
Snow–ice	0.4 (0.1)	7.3 (2.7)	−0.7 (−0.3)	12.4 (4.6)
Aqua Type	Clear sky Bias ($W m^{-2}$) (%)	Clear sky RMS ($W m^{-2}$) (%)	Cloudy sky Bias ($W m^{-2}$) (%)	Cloudy sky RMS ($W m^{-2}$) (%)
Forest	−1.2 (−1.0)	3.9 (3.0)	−3.6 (−1.2)	7.2 (2.3)
Grassland	−2.6 (−1.5)	3.2 (1.8)	−3.8 (−1.3)	6.2 (2.1)
Cropland–urban	−2.3 (−1.4)	3.6 (2.3)	−3.7 (−1.2)	6.9 (2.2)
Bright desert	−3.9 (−1.2)	4.1 (1.3)	−4.1 (−1.2)	6.2 (1.8)
Tundra–barren	−3.1 (−1.4)	3.7 (1.7)	−3.2 (−1.1)	9.6 (3.5)
Water	−1.4 (−1.6)	2.8 (3.3)	−2.5 (−1.1)	11.8 (5.3)
Snow–ice	−5.4 (−2.0)	9.0 (3.3)	−4.1 (−1.6)	10.8 (4.2)

FLASHFLUX: Schematic Mapping to Current Example Uses